PATENT SPECIFICATION

DRAWINGS ATTACHED

Inventors: HENLEY FRANK STIRLING and CYRIL FRANCIS DRAKE

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COMPLETE SPECIFICATION

Improvements in or relating to Semiconductor Devices

We STANDARD TELEPHONES AND CABLES LIMITED, a British Company, of Connaught House, 63 Aldwych, London, W.C.2, England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to semiconductor devices containing a *p-n* junction or junctions.

It is well known that a high voltage limit is set by the breakdown of a rectifying *p-n* junction where this junction meets the semiconductor surface, and that it is desirable to protect this vulnerable area of the device so that the theoretical electrical properties of the bulk semi-conductor may be realized without the limitation of surface breakdown.

An object of the invention is to effect such protection.

According to the invention there is provided a method of manufacturing a *p-n* junction semiconductor device which includes the step of providing on a body of semi-conductor material containing a *p-n* junction a layer of a nitride of silicon at least over the area or areas of the body where the *p-n* junction emerges at the surface thereof.

The invention will be described with reference to the drawing accompanying the Provisional Specification which shows semiconductor body 1 containing a *p-n* junction 2 formed between regions 3 and 4 of opposite conductivity type. A layer 5 of a nitride of silicon is provided on the body 1 so as to provide a protective layer for the *p-n* junction 2 where it emerges at the surface of the body 1.

In the vapour phase processes of single crystal deposition of silicon (so called epitaxy) for instance where *p-n* junctions are fabricated by controlled doping, it is desirable also to deposit a protective layer from the vapour phase by a change of gas atmosphere and a similar heat treatment.

In this invention it is proposed to protect exposed *p-n* junctions (made by any means) by the deposition from the vapour phase of a nitride of silicon for example Si_3N_4. A mixture of substantially pure nitrogen and pure hydrogen is bubbled through silicon tetrachloride and impinges on to the heated semiconductor element where a nitride of silicon (or a mixture of nitrides) is deposited by thermal decomposition.

Alternatively a nitrogen hydride, for example ammonia (NH_3) or hydrazine (N_2H_4), vapour is mixed with a silicon hydride, for example silane (SiH_4) and these are decomposed and recombined at the semiconductor surface which may be heated. Decomposition and recombination may be effected by an RF initiated gas plasma or other electric discharge. Hydrogen or inert gas may be used as a carrier in this reaction.

Similarly halogen compounds of ammonia or compounds such as disilylamine $(SiH_3)_2NH$, may be used in these reactions.

In a specific example, hydrogen purified by diffusion through palladium metal and flowing at ½ litre per minute is mixed with dry nitrogen which has been further purified by contact with red hot copper and flowing at 1 litre per minute. The mixed gas flows through liquid silicon tetrachloride cooled to between −60° C and room temperature after which the mixture impinges on to a slice of silicon containing exposed *p-n* junctions and heated to 950° C. A layer of silicon nitride is deposited whose thickness depends on the temperature of the silicon tetrachloride, the gas flow rates and the system geometry, and may typically be of the order of 2 to 20 microns.

[*Price*

WHAT WE CLAIM IS:—

1. A method of manufacturing a *p-n* junction semiconductor device which includes the step of providing on a body of semiconductor material containing a *p-n* junction a layer of a nitride of silicon at least over the area or areas of the body where the *p-n* junction emerges at the surface thereof.

2. A method as claimed in claim 1 in which said layer comprises Si_3N_4.

3. A method as claimed in claim 1 or 2 in which said layer is provided by deposition from the vapour phase of a gaseous atmosphere including silicon and nitrogen.

4. A method as claimed in claim 3 in which said atmosphere comprises a mixture of substantially pure nitrogen and pure hydrogen passed through silicon tetrachloride.

5. A method as claimed in claim 3 in which said atmosphere comprises a mixture of a nitrogen hydride and a silicon hydride.

6. A method as claimed in claim 5 in which the nitrogen hydride is ammonia.

7. A method as claimed in claim 5 in which the nitrogen hydride is hydrazine.

8. A method as claimed in claim 3 in which said atmosphere comprises a mixture of a halogen compound of ammonia and a silicon hydride.

9. A method as claimed in any one of claims 5 to 8 in which the silicon hydride is silane.

10. A method as claimed in claim 3 in which said atmosphere comprises disilylamine.

11. A method as claimed in any one of claims 3 to 10 in which deposition is effected thermally by heating the semiconductor body.

12. A method as claimed in any one of claims 3 to 10 in which deposition is effected by an RF initiated gas plasma or other electric discharge.

13. A method of manufacturing a *p-n* junction semiconductor device substantially as described with reference to the drawing accompanying the Provisional Specification.

14. A *p-n* junction semiconductor device manufactured by the method claimed in any one of the preceding claims.

J. N. CLAYTON
Chartered Patent Agent
For the Applicants.

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1006803 PROVISIONAL SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*